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A REVIEW ON POWER MANAGEMENT TECHNIQUE HYBRID MICRO-GRID SYSTEMS

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ABSTRACT

In the current energy scenario, renewable energy resources are the key alternative to fossil fuels in order to meet the ever --increasing demands across the world. Renewable energy system plays a vital role for the reliability of the power system. Due to the intermittent and random probability distribution nature of each renewable sources Hybrid systems are coming into existence. Use of hybrid systems is an effective solution to energy storage and Power quality features. As the technologies are developed to operate the renewable energy source as grid-connected rather than islanding mode energy storage system gain a more attention in decentralized power system. Micro grid energy management systems are key components for ensuring the stable and economic operation. By using different storage techniques such as Battery, Super capacitor, Ultra capacitor, Multilevel inverter and Fuzzy logic rules these power management systems are popular in integrated operated renewable systems. The energy storage systems are most basic and popular amongst all the distributed energy sources of energy storage systems. However, the management and quality of hybrid energy systems based micro grids are difficult.

Keywords: Battery, Super capacitor, Multilevel Inverter, Fuzzy Logic Rules, Power Quality, Ultra Capacitor

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Original Article

INTRODUCTION

Energy plays a key input for the economic growth of a country. Electrical energy is the main form of energy dispersed across the world. Based on the utilization of electric energy the degree of the development of country can be measured. As we are moving to a more competitive environment electricity markets plays a tremendous transformation like decentralization of power system with distributed generation (DG). But the challenges in the present generating system are because of decreasing the oil resources, and the environment, political concern of nuclear generation. So the researchers, practitioners and policymakers to look for alternative and sustainable sources of energy. There are many reasons a customer may choose to install a distributed generator such has due to the meeting of the peak load demand and also it is one of the solutions to meet the emergency loads and also because of continuity and reliability green power sources gain a lot of attention. In some remote locations, DG is installed as it is less costly and eliminates the need for expensive construction of distribution and/or transmission lines. By using the PV cells Solar energy can be utilized directly from the sun, whereas wind, wave, hydro etc energies are utilized by using turbines. Integrated utilization of different renewable energy sources may overcome the drawbacks and helps in increasing the reliability of power and energy storage with the reduction of system cost.

However, cattle dung, waste from an agricultural field, forest foliage, solar intensity water streams, wind etc, are widely available in the remote areas. By utilizing of these resources in off-grid mode, it would be the most reasonable solution for accessing the energy in rural areas. The selection of optimization is based on the cost analysis i.e by considering the lowest value of the cost of energy, net present cost, with the maximum value of renewable fraction and lowest harmful emissions. Analysis of different types of models should be considered by comparing economy and environment. Rural electrification plays a key role in the remote areas for accessing energy and also the energy supplied to such areas can be operated through the machinery of agricultural applications.

The average changes in power surges are controlled by the contribution of storage batteries and Super capacitor. It also effects to improve in the fast DC link voltage regulation and also effective energy management systems. It also reduces the sudden changes of current stresses in the battery. [1] The main objective of this paper is to meet the load requirements. The energy storage systems are most basic and popular amongst all the distributed energy sources of energy storage systems. However the management and quality of hybrid energy systems based micro grids are difficult. Therefore it is a challenging task for the following reasons:

The availability of renewable energy sources due to its intermittent and stochastic nature leads to discontinuous supply [2]. The controlling and management of Hybrid Energy Storage System is difficult due to sudden changes of load variation [1]. The sudden changes in the load may effects the battery lifespan. The grid frequency and dc bus regulation need to be operated within its safe state of charge. Power should be satisfied with the limited utilization of ac and dc microgrids. The voltage should be constant throughout the supply by eliminating the voltage ripples in the o/p of the micro grids. Energy storage systems play a major rule for effective operations of dc link regulation and frequency dependent loads. Also, these storage systems need to place a major role for the high state of charge of limits [3].

The maximum utilization of renewable energy sources is the important factor by reducing the power losses. So the decoupling of both AC and DC micro grids ensures these power losses. Here the power is exchanged for both ac and dc micro grids so that the load demand is satisfying for the utilizing power through a bi-directional converter. A bidirectional converter can act as both inverter and rectifier, so simultaneously we can able to transmit both ac and dc power [4]. By using Ultra capacitor the uncoordinated charging and discharging capabilities of Energy storage systems causes high power losses and voltage deviations [10]. Now a day's Micro grids are considered as the subset of smart grids due to its higher reliability and flexibility. In other words, the battery storage systems are considered as the backbone of the entire renewable systems. Every system must need a backup source for emergency conditions [5]. Here the fuzzy-based isolated DC micro grid is proposed, photovoltaic and Ultra capacitor based energy sources are used as storage devices. In this technique, the DG is used an alternative source in the peak loads to meet the demand and also as a backup source to increase the reliability of the total energy systems [6].

System Configuration and Proposed Techniques

Considering all the above perspective issues, the combined energy management schemes are been proposed. The proposed energy management based hybrid micro grids are listed out briefly as below. MAS-based energy management strategies have come into existence, i.e. these systems can meet the load with high demands and continuity of supply and also proper management scheme is necessary for optimization. The control strategies also necessary to acquire reliable and flexible power management schemes. By considering all these parameters MAS are taken into account. [2] The hierarchal

and control strategies of this system are of four types.

- Middle-Level Coordinated control systems are used to implement the switching control operations to ensure flexible and continuous energy supply systems.
- The event triggered conditions are designed by different switching controls like inhibitive switching; coordinated switching control and hybrid controlled switching between the control strategies agents.
- The Swapping operations are done by these switching controls in a coordinated manner.
- It is a centralized implemented method by the process the constraints of both computational and conventional centralized management techniques.

Using Battery Super Capacitor

Battery Super capacitor based energy storage systems are placed a vital role and most popular amongst all the energy storage systems. To protect the system from the sudden changes of load variations and sudden surge and peak loads Super capacitor is used, so that life expectancy of by relieving the battery is increased. The high battery state of charge limits is eliminated by using this scheme. The importance of this method is to provide a constant method of designing the control strategies within prescribed limits [1]. A control approach is required for the management of power flow fast dc link regulation and satisfactorily operated loads of local bus voltage.

Table 1: Characteristics of Typical ESS [20]

Energy Storage	Ramp Rate/Power Capacity	Power Capacity KW	Energy Capacity KW	Applications
Lead Acid Battery	>0.18KW/ma / 1.26KW	<100	1-1000	Power quality Renewable Source integration
VRB	31MW/s / 6MW	10-10^7	<10^6	Frequency regulation Power Quality
Fuel Cell With Electrolyzer	0.25KW/min / 3KW	<100	<2*10^6	Vehicles Time Shifting
Ultra Capacitor	Considered Infinite	1-100	<1	Frequency Regulation Transient Stabillity
Compressed Air	18MW/Min / 110MW	10-10^6	10-10^6	Load Shifting

MAS Based Energy Strategy

For the consumers and the utility system the voltage and frequency should maintain constant throughout the supply. The critical and frequency dependent loads are effectively operated and monitoring of grid frequency is an important task for the micro grid. So we should consider the main conditions of both ac and dc micro grid for reliability and regulation of local bus voltage and bus regulation [2]. Multi-level energy management system also provided for achieving the control accuracy. Bus voltage deviations, power tracking errors are compensated by using the ESS [20].

Normally hybrid energy system entails multiple energy systems, with an energy storage device, along with the controller and a power conditioning unit. We can operate the system in any. This includes advance research in one of the mode i.e by grid-connected or islanding mode with the help of the real time optimization techniques like fuzzy logic,

artificial neural network, perturb and observe algorithms etc the system can power flow and other parameters are controlled Therefore, it is essential to have a comprehensive study and performance analysis of a PV model to predict the outcome of a PV module under diverse atmospheric conditions.

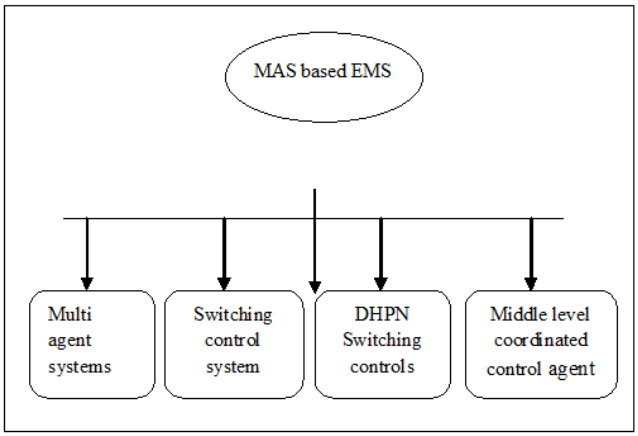

Figure 1: MAS Based Hierarchal Scheme [2]

For high power density and dynamic built energy storage systems such as Ultra capacitor are came into existence. It improves the enactment of the battery storage units. This technique mainly focuses on the design of a local users control system which ensures a high state of charge limits and overcharges security for the energy storage devices. It reduces the high surge peaks and current stresses on the battery by diverting. So that it helps to improve the performance of the battery and also lifespan of the battery gets increased [2].

Grid Adaptive Management Strategy

The microgrids can helps to supply the power to remote areas. By using both the AC and DC microgrids it can easily be reduced the power losses and also eliminated the inverting equipment caused by both ac/dc microgrid converters. DC microgrids can provide several benefits when compared to the ac microgrids. 1) Efficiency is more. 2) Power losses can be reduced. 3) Easy to handle the photovoltaic cells and storage batteries. 4) To synchronize the buses 5) Supply the dc supply to Laptops, Electric vehicles, Led lights etc. [7] The Diesel generator is used for better integration of ac and dc microgrids to the power grids. Mutually ac and dc microgrids systems are must be maximized the efficiency.

Robust Optimal Management Strategy

Optimization based techniques are gaining more attention to satisfy the power demand. The hybrid ac/dc microgrids can decouple ac sources with ac loads and dc sources with dc loads by using bi-directional inverter/converter. In this technique, the battery banks and Diesel generators are used as the back up source for the systems. The unnecessary of multi conversion processors is eliminated which reduces the reduction losses. The optimization of power management systems is used to maximize the efficiency of the whole system [4].

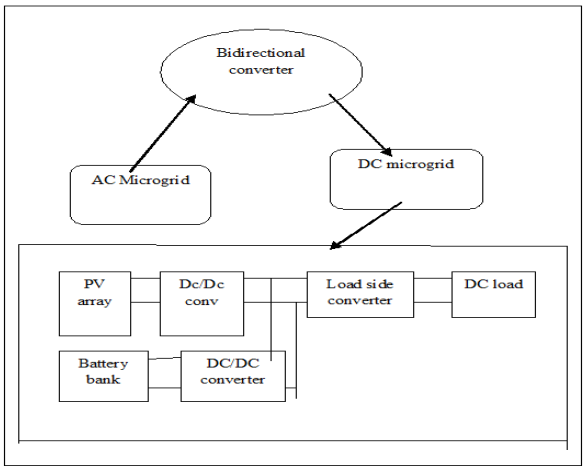

Figure 2: Typical AC and Dc Microgrid Configuration [4]

A microgrid must operate in two modes: Standalone mode and grid-connected mode. It is necessary to operate in different mode while it is connected to the grid in order to maintain reliable, flexible, and continuous supply. The renewable energy systems based DC microgrid consists of generating sources and acts as an energy backup system which may be independent or connected the grid [5].

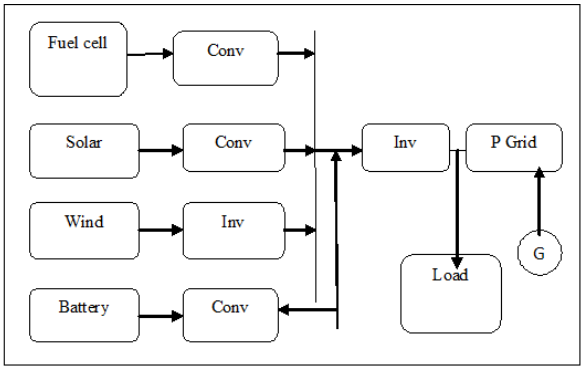

Figure 3: Grid Connected Microgrid [5]

Fuzzy Based Control

A typical AC/DC microgrid a power management system is proposed for the state of charge limits of the battery. Here because of the irregular and unpredictable environment of renewable energy sources, a diesel generator is used as the backup source to increase the reliability and flexibility of the system. The DG is operated in between the power converters of ac and dc microgrid for improving the power quality and reliability. In order to achieve the desired state of charge limit it is advisable to use separate battery banks for the particular ac/dc microgrids. The controller is coordinated in such a way that power can be managed in between both ac and dc microgrids. The supervisory controller is used to manage the different types of load conditions [6]. Here the fuzzy-based isolated DC microgrid is proposed, photovoltaic and Ultra capacitor based energy sources are used as storage devices. In this technique, the DG is used as a backup source to escalation of the reliability of the total energy systems [7-8].

Multilevel Inverter

By using this multilevel inverter the power quality of the system will be improved. The output of the renewable energy sources like solar is dc. By approaching different methods that dc is converted into the ripple free voltage having a

less harmonic reduction. In this method, H-bridge multilevel inverter is used for improving the power quality of the systems. Before using this method we should properly analyze the performance of microgrid system for various load variations. The reduced harmonic distortion will be keenly observed by the output voltage levels. The current at unity power factor is delivering to the grid. It is also helpful for increasing the efficiency by reducing the switching losses [9-11].

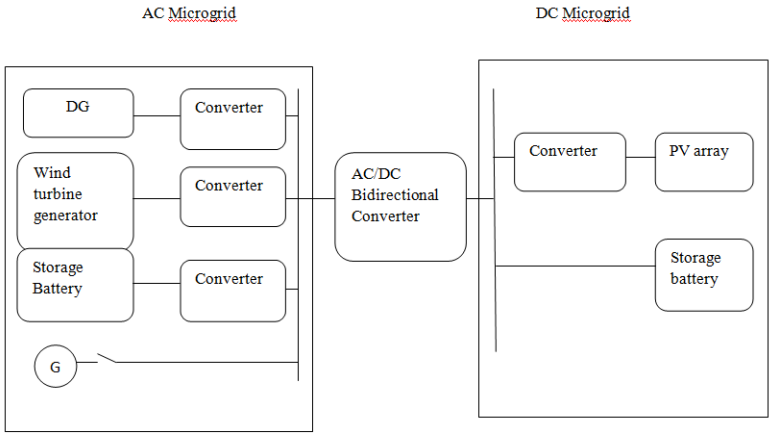

Figure 4: Typical Hybrids AC/DC Microgrid [6]

Power Management System for Islanded Micro Grid

It is difficult to operate in islanded microgrids by using battery storage, In order to regulate voltage and frequency in the absence of synchronous generators. The new technique came into existence i.e through a voltage sourced converter [12] energy storage can be connected to the microgrid. The continuity of service is increased by using Distributed generation system. The micro grids are equipped with several suitable control systems and equipped embedded generators. It is always allowable for the households loads to operate in the islanded mode in the presence of energy storage devices. A control flow energy management system has been developed for the automatic operation of standalone micro grids into embedded systems. The state of charge of limits has been controlled in the cases of most critical operations in the islanded microgrid [13]. The system reliability and efficiency has been increased by using droop control methods [14]. The energy storage systems of battery storage capacity are increased by using droop control methods.

The different operational modes are achieved by using smooth switching droop control methods [15]. The utilization of renewable energy sources is achieved by using coordinated active power regulation with distributed power management systems and photovoltaic generation. This active power regulation will control the state of charge of limits within the range [16]. Forgetting dynamic energy management system the energy storage devices like battery are using as a backup source for the micro grid system [17]. The communication links are used within the tuning control drop for controlling the output voltage of the inverter [18]. The exchanging of the information between two layers from diesel generators and loads is through the communication network. Power management adjusting has achieved this method by reducing minimization problem [19-20].

FUTURE STRATEGIES

The performance criteria of the battery units can be improved by using a dynamic and high power density based energy storage device (ESD) such as ultra-capacitors in the existing system performance Battery-super capacitor-based hybrid energy storage systems (HESS) combine the benefits of each energy storage devices (ESDs) and used to extend battery life expectancy by diverting transient battery current to the super capacitor units [3]. The energy management

schemes should achieve the main function of real power transfer along with the additional power quality features such as current harmonic compensation, reactive power support and unity power factor operation at the point of common coupling [2]. In order to improve the power quality the H-Bridge multilevel inverter is used, and the total harmonic distortion in output voltage waveform of the multilevel inverter will be reduced as the number of levels of output voltage waveforms will be increased [5].

An intelligent control strategy is also necessary to ensure a reliable and flexible energy supply system. Middle-level coordinated control agents are added in order to implement the switching control between operation modes between DERs to ensure the energy supply system is reliable and flexible [6]. The usage of super capacitors reduces the current stress on battery the battery.

A two-stage power control strategy is proposed to smoothen the power output of a grid-connected PV power plant[1]. A supervisory controller is used to manage the operating modes of the system, which selects the proper mode among three possible operating modes. A DG is used as a backup source to increase the reliability of the system[9].

CONCLUSIONS

Due to intermittent and unpredictable nature renewable energy resources coupled with the unpredictable changes in the load demands high power and energy density storage systems to do exist in today's microgrid environment. So that the energy storage systems are gaining more attention in the modern electric grid due to the rapid growth of renewable grid integration. Among all those battery energy storage systems are gaining more attention and considered to be the most basic and popular amongst distributed network due to their easy implementation and geographical independence as compared to other storage technologies. By discussing various types of storage systems in this paper helps us to improve the supply system in all aspects.

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